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IMPROVEMENT OF
CALABAZAS CREEK CHANNEL
FROM STATION 9+51.9 TO 119+27

To:

MARK THOMAS & COMPANY
18 N. SAN PEDRO
SAN JOSE, CALIFORNIA

SANTA CLARA VALLEY WATER DISTRICT
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By:

TERRATECH, INC.
193 E. Gish Road
San Jose, California

March, 1969

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Direct Shear Test

March 25, 1969
Project 1099

Mark Thomas & Company
18 N. San Pedro
San Jose, California

Attn: Mr. Sam Zullo

Subject: Improvement of Calabazas Creek Channel
from Station 9+51.9 to 119+27

Gentlemen:

This report presents our foundation recommendations for the proposed improvement of Calabazas Creek channel between the subject stationing.

The proposed improvement consists of straightening the present channel alignment and lining the lower eight (8) feet ± of the creek section.

Our study included: (1) an evaluation of the properties of borrow material from the test percolation pit, located near the intersection of Bubb Road and McClellan Road, and (2) an evaluation of general soil properties along those portions of the creek channel which are to be cut, forming the side slopes of the improved facility. We have not made detailed measurements of soil strength properties or soil classification from either the area limits of the proposed borrow source, or the side slopes along the entire reach of channel to be improved. That work has already been performed by the Santa Clara County Flood Control and Water District.

Findings

After completing our field investigation and laboratory testing program, we have reached the following conclusions regarding soil properties.

a) Borrow Source - These soils are essentially granular in texture grading from cobbles larger than six (6) inches down to a trace of fines smaller than the number 200 mesh sieve. We sampled the coarse as well as the fine strata. However, size difference as presented on the Gradation Curve in the appendix is virtually all in the size range between the number 30 sieve and the three/fourths (3/4) inch sieve; see natural material, south slope, and natural material, west slope. There was no appreciable change in the amount of fines.

In an attempt to evaluate grain size breakdown effect resulting from "working" this borrow material during construction, we subjected a second sample from the west slope to a moderate amount of pounding with a standard drop hammer before performing a comparative mechanical analysis. The amount of fines passing the number 200 mesh sieve only increased from four percent (4%) to seven percent (7%) by weight, an insignificant increase. Therefore, even with "breakdown" effect, fill slopes will consist primarily of non-cohesive, granular soil.

In order to determine the maximum stable slope at which the fill could be placed within the channel, a representative sample of the finer soil particles was tested in direct shear. The prescribed test density of this strength test was based upon a laboratory compaction curve developed from a composite sample obtained from both the south and west slopes of the test pit. This test data is attached.

If used alone, results from the direct shear test might suggest the borrow material has a relatively high cohesion intercept as well as a high friction angle. If such a high cohesive force were available, steep side slopes could be expected to remain stable for reasonably deep channels. However, both the gradation curves discussed earlier and the behavior of the fill material during compaction testing cast a very reasonable doubt on the validity of the measured cohesion intercept. With measured clay-silt content varying between one percent (1%) and seven percent (7%), the composite sample would be expected to have little if any real cohesion. The compaction sample of this soil, tested with a below optimum water content (7%) could not be extruded from the compaction mold as a single unit. Such samples were extremely friable and behaved typically as a completely non-cohesive granular soil.

Undoubtedly the apparent cohesion of the sample is at least partially due to the method of sample preparation for shear testing as well as to capillary forces between the finer particles. All particles larger than medium sized sand (number 16 sieve) are screened off when preparing the sample for testing. This screening off process changes the four percent (4%) fine content for the original sample mix to an artificially high value of eighteen percent (18%) fines by weight.

While the cohesion intercept is suspect, the friction angle measured in the direct shear test is probably a fairly reliable estimate of an average strength value for proposed fill. Considering a normal variation of soil properties within the mass to be excavated from the borrow source, we estimate such material would have an average ϕ angle approaching forty degrees plus or minus (40°±). Unfortunately, this angle, while high, is not sufficient without a reasonable amount of soil cohesion to support the proposed one on one channel side slope.

Cut slopes in the percolation test pit vary from a minimum of about forty degrees (40°) to a high of about fifty-two degrees (52°). These steep slopes, however, are only stable because of the natural cementation of the alluvial deposit. Once the borrow material is excavated and reworked, all cementation would be essentially lost, limiting the as constructed slope to something less than forty degrees (40°). I could not determine how much of the observed slope variation in the test pit is due to selective erosion of the less cemented strata, or how much slope variation may be simply the result of final shaping during original excavation.

b) Natural Channel Side Slopes - Soils forming the side slopes of the present channel alignment vary from clayey sands and gravels to plastic silty clays. These materials are exposed in a clean erosional face over most of channel length but in certain locations are masked by trees and large shrubs. Some parts of the channel, and in particular the upper reach between Stevens Creek Boulevard and Wolfe Road contain miscellaneous debris such as broken concrete slabs, broken asphalt pavement, wasted ready-mix concrete, and general trash, end dumped over bank top.

I was unable to examine much of the base soils in the channel bottom because of the heavy stream bed load. However, most of the channel bed appears to consist of a hard silty clay that has a high tractive resistance to stream scour. A thin two foot plus or minus (2'±) layer of thinly bedded siltstone, claystone was found in the channel base just above Stevens Creek Boulevard, sandwiched in between two zones of the hard silty clay. This siltstone strata may be a rather common feature in the channel which was not observed because of the heavy stream deposition. The silty clay basal strata is inturn overlain throughout most of the project reach by a two (2) to five (5) foot thick clayey gravel. This second zone also has high stability and resistance to stream scour, stabilizing at slopes steeper than fifty degrees (50°). In many locations this gravel zone was measured at near vertical faces as high as five (5) feet above base level.

While these two common types of lower soil strata appeared rather constant throughout the channel alignment, the type and consistency of the upper soil zones were quite varied. As presently proposed on preliminary design plans, these upper soils will constitute the major portion of the unlined section of improved channel. In areas to receive fill along the planned realignment, these upper soils will be protected by placement and compaction of imported borrow. However, in those particular reaches of channel requiring cutting back into natural banks in order to provide channel design cross section, the upper soils must be able to support themselves without benefit of either lining or protective fill. These particular points along the channel were evaluated for probable stability.

Measured soil cohesive strength and existing angle of slopes at proposed cut stations are listed in the appendix.

The timing of my on-site investigation was rather fortuitous. It was made just after the winter storm flows had occurred and channel access was not a major problem; yet the evidence of local bank failures which occurred during the past season were still fresh and most bank surfaces were still wet enough to obtain some meaningful indication of in-situ cohesive shear strength.

The flattest stable slope angle measured along the length of channel within the limits of the proposed improvement was the recently re-dressed reach between station 74+80 and 85+100. This reach has an average straight line slope of about thirty-five degrees (35°) and still appears to be stable after this short period of service since renovation.

More burrowing activity was noticed within this reach of channel than was observed within the remainder of the entire project. This animal activity is serious enough to merit some special consideration in future maintenance programs planned for the improvement project. Certainly similar animal activity can be expected at other locations along the channel if banks are stabilized and sloped to allow easy access to water from top of bank where burrows are usually located.

The flattest slope angle measured on naturally stabilized banks above the clayey gravel strata was thirty-seven degrees (37°). This angle was measured at station 49+00 in a wet, clayey sand.

Recommendations

The following recommendations should be considered in formulating general design criteria for channel improvement. Both cut and fill slopes planned for the lined portions of the improved channel are quite steep. We recommend a slight reduction in the inclination of planned fill slopes and a corresponding slight increase in cut slope inclination thus enabling channel construction to be completed essentially within the same lateral dimensions as set forth on the preliminary drawings. In order to protect lined sections from high water pressures (uplift) during periods of rapid fluctuations in channel water level (rapid draw-down conditions) weepholes and an under drain system should be constructed in the lining subgrade. If you wish, more specific recommendations concerning this drain can be furnished in a supplemental report. In any event, we would like an opportunity to review the design of this system prior to actual construction.

A) Fill Slopes - Because of a lack of cohesive strength in fill from the proposed borrow site, fill slopes can not be expected to stand as steep as the forty-five degree (45°) slope originally proposed by the Santa Clara County Flood Control and Water District. Any fill slope constructed steeper than thirty-eight degrees (38°) (1 vertical on 1¼ horizontal) may be rather close to incipient surface failure. Considering ease of fill construction as well as normal shear strength variation in any large mass of earthwork, design fill slopes for the average channel section should be limited to thirty-four degrees (34°)(1 vertical on 1½ horizontal). This slope should provide a reasonable and safe configuration for compacted fill placed either as subgrade for concrete lining or to meet design limits for the upper unlined slope. Somewhat steeper fill slopes may be specified where channel access points are constructed and slope is protected with a concrete lining, but should in no case exceed thirty-eight degrees (38°). This steeper slope, of course, while most probably stable as an unlined slope, has a greater potential for surface sloughing than does the flatter slope recommended for the main channel. Steeper slopes, un to ninety degrees (90°), if necessary for the project can be accommodated by designing the concrete section as a rigid frame with controlled backfill behind structural walls.

Based upon one ASTM D1557-66T control compaction curve, maximum compaction of the borrow to be used on the project is 135 pounds per cubic foot at seven percent (7%) optimum water content. Other control compaction tests should be performed during the construction phase of channel improvement on both borrow and material excavated from the channel to provide necessary field checks on the contractor's fill performance. All fill placed in the channel should be compacted to a minimum eighty-five percent (85%) relative compaction (ASTM D1557-66T) in horizontal lifts. Such lifts should be at least two (2) feet wider than final slope line, and should be keyed eighteen (18) inches horizontally into natural ground. After completing fill placement, the overfilled slope should be trimmed to final grade. No end dumping over bank top or slope surface compaction should be permitted on this project.

If the contractor mistakenly over excavates any cut banks, he should bring the slope back to grade in a similar manner specified above for "fill" including the requirement of a two (2) foot horizontal extension of fill over final grade line.

No deleterious material should be allowed in the channel fill, however, all clean soils excavated from the existing channel slopes may be blended with borrow fill. The thinly bedded siltstone and claystone which may be encountered near the creek base should not be placed in any fill unless well broken and thoroughly blended with other fill soils.

In order to minimize future slope stability problems and maximize long term channel performance, all phases of placement should be observed and tested by a qualified inspector.

B) Cut Slopes - After examining those specified areas of existing channel to be cut to form either subgrade for concrete lining or the upper unlined channel slopes, we recommend increasing allowable slope excavation to a maximum value of thirty-four degrees (34°), rather than the twenty-seven degrees (27°) shown on the preliminary cross sections furnished by your office. This steeper configuration (1 vertical to 1½ horizontal) should be stable requiring only a minimum amount of annual maintenance. Certain cut slopes may safely stand on even steeper angles, but shear strength of the average in-place soils along Calabazas Creek does not warrant such additional slope steepening as a general design parameter.

In particular areas of limited right-of-way where there is insufficient room for both the recommended thirty-four degree (34°) cut and fill slopes, and top of bank erosion control, we suggest using the full right-of-way width to meet suggested slope angle. Over bank erosion control in these limited width areas can be provided by extending the lining to the full height of the channel. Steepening the slope may be somewhat less costly than lining the upper slope above the normal section, but any local slope failure in the narrow channel could possibly involve some of the adjacent property and structures.

Conclusions

Based upon our investigation of soil from the proposed borrow source and along planned cut sections of Calabazas Creek, we recommend modifying the preliminary cross section configuration of the improved channel. Instead of building the channel as a one (1) to one (1) lined section topped by an unlined one (1) vertical to two (2) horizontal slope, we recommend building the entire height of channel on a one (1) vertical to one and one-half (1½) horizontal slope.

Where special problems of transition between standard channel sections and access ramps exist, somewhat steeper fill slopes may be constructed. As slopes become steeper, of course, the risk of local slope failures becomes higher. In no case, however, do we recommend constructing fill slopes steeper than one (1) vertical to one and one-forth (1¼) horizontal.

All fill should be compacted to eighty-five percent (85%) maximum compaction as determined by ASTM D1557-66T.

Our office has the personnel to perform the important function of construction inspection and would like to offer our services in this capacity to the Flood Control District when construction begins.

We trust this report meets your specific design needs. If you require further information please let us know.

Very truly yours,

TERRATECH, INC.

Wayne E. Ferree

Wayne E. Ferree

WEF:jpt

encls.

APPENDICES

CHANNEL STATION		SOIL TYPE	SHEAR STRENGTH Ton/SF	SLOPE ANGLE	COMMENT
E 14+50	CL	Plastic sandy CLAY over hard CLAY BASE	0.5	60°	Sloughing
E 19+00	CL CH	Wet, clayey SAND over hard CLAY BASE	0.25	55°	Sloughing
E 21+75	CL GC	Wet, plastic sandy CLAY over 2' clayey GRAVEL BASE	0.7	38°	
E 34+25	CL	Moist, plastic silty CLAY	0.75	45°	Sloughing, large amount o debris
E 39+00	SC GC	Moist clayey SANDS over 5' of clayey GRAVELS		45° 55°	
W 43+00	SC GC	Clayey SAND over Clayey GRAVELS	0.25	46° to 52°	
W 49+00	SC GC	Wet clayey SAND over 3' clayey Gravels	0.20	37°	
W 79+50	CL GC	Dry silty CLAY over clayey GRAVEL		35°	Very stable but heavy borrowing activity between STA 75 and 85
W 82+00	CL CH	Moist, plastic silty CLAY over hard clay	0.7		
E 95+50	CL CH	Moist, plastic silty CLAY over hard clay	0.85	38°	Contains one local slip out
E 100+00	CL CH	Moist silty CLAY hard CLAY BASE	0.80	51°	Sloughing
W 103+50	CL	Silty CLAY		44°	Stable
W 109+00	CL	Moist silty CLAY	0.72	48°	Highly erodible
E 114+00	SC GC CH	Clayey SAND over Clayey Gravel over hard clay base	0.25 0.70	35°	high Ø

CHANNEL STATION		SOIL TYPE	SHEAR STRENGTH Ton/SF	SLOPE ANGLE	COMMENTS
E 117+40	CL	Moist silty CLAY	0.68		
E 117+50	CL	Wet silty CLAY (soft)	0.45	33°	Stable

PROJECT 1099

TERRATECH

GRADATION TEST RESULTS

Hole No.

Tested By

Area

Appr. By

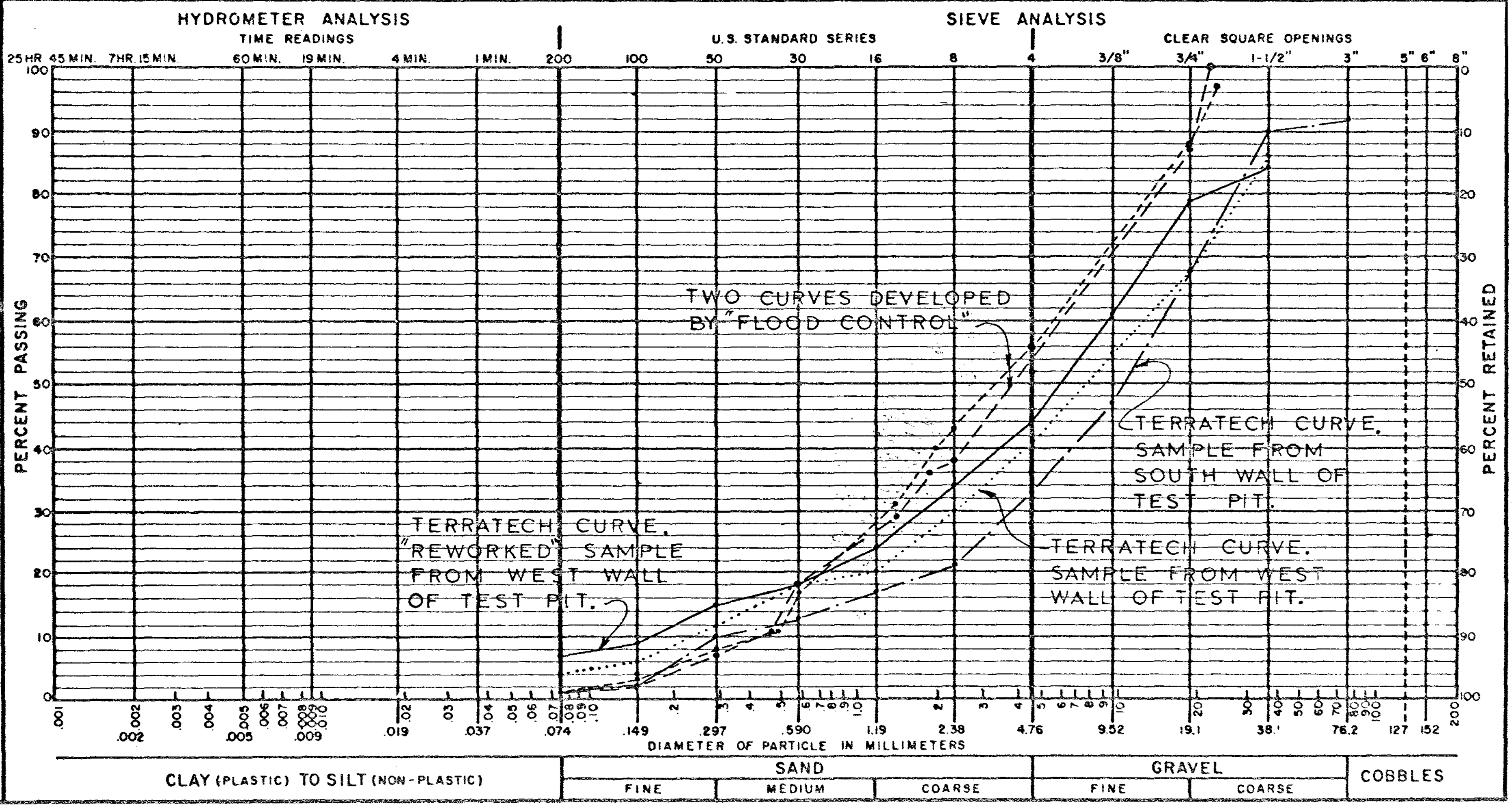
Date

Job No.

File No.

Fig. No.

LL									
PL									
PI									
NAT. W/C									
CLASSIF. SYMB.									
SAMPLE NO.									
DEPTH FT.									
HOLE NO.									



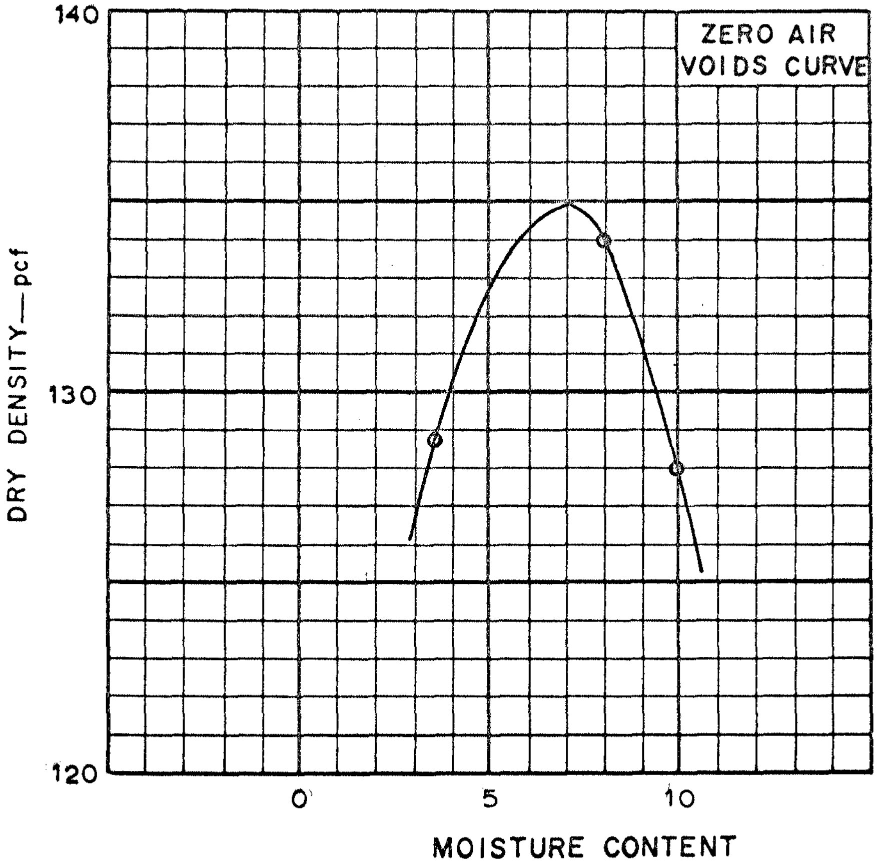
TWO CURVES DEVELOPED BY "FLOOD CONTROL"

TERRATECH CURVE. SAMPLE FROM SOUTH WALL OF TEST PIT.

TERRATECH CURVE. "REWORKED" SAMPLE FROM WEST WALL OF TEST PIT.

TERRATECH CURVE. SAMPLE FROM WEST WALL OF TEST PIT.

COMPACTION TEST



SAMPLE NO.

SAMPLE DEPTH

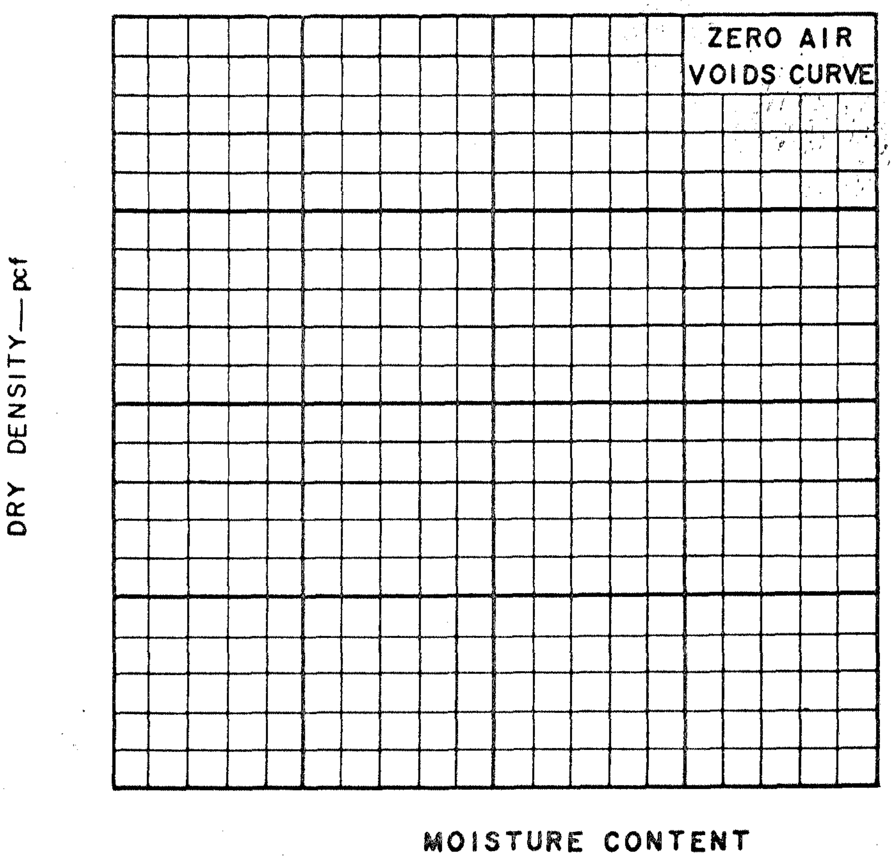
SAMPLE DESCRIPTION
MIXED SAMPLE,
PERCOLATION
TEST PIT AT
BUBB ROAD.

SPECIFIC GRAVITY

TEST DESIGNATION
ASTM
D1557 - 66T

MAXIMUM DRY DENSITY (pcf)

OPTIMUM MOISTURE CONTENT, %



SAMPLE NO.

SAMPLE DEPTH

SAMPLE DESCRIPTION

SPECIFIC GRAVITY

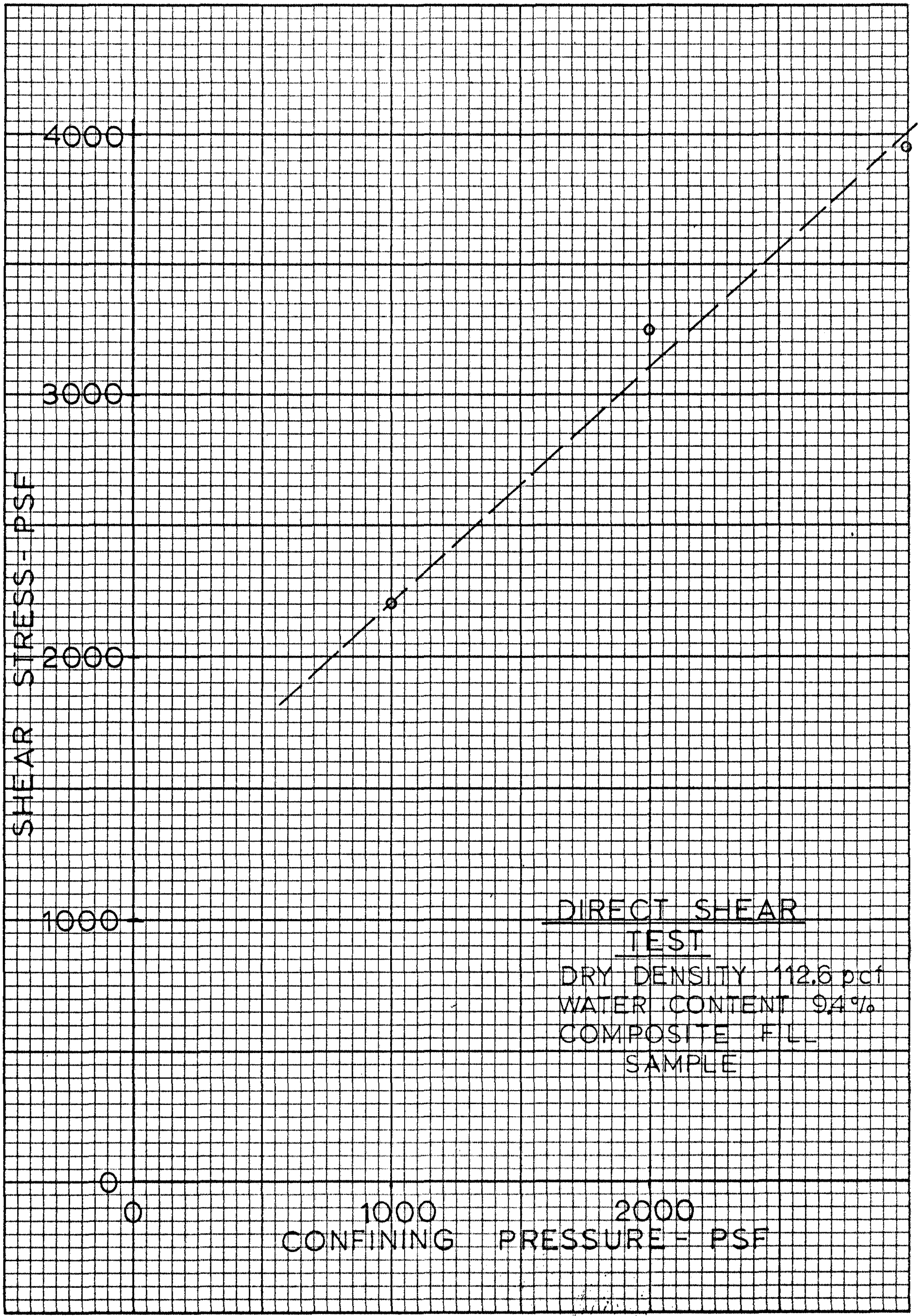
TEST DESIGNATION

MAXIMUM DRY DENSITY (pcf)

OPTIMUM MOISTURE CONTENT, %

PROJECT NO. 1099 TERRATECH

K+E 10 X 10 TO THE INCH 46 0703
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.



DIRECT SHEAR TEST

DRY DENSITY 112.6 pcf
WATER CONTENT 9.4%
COMPOSITE FILL
SAMPLE

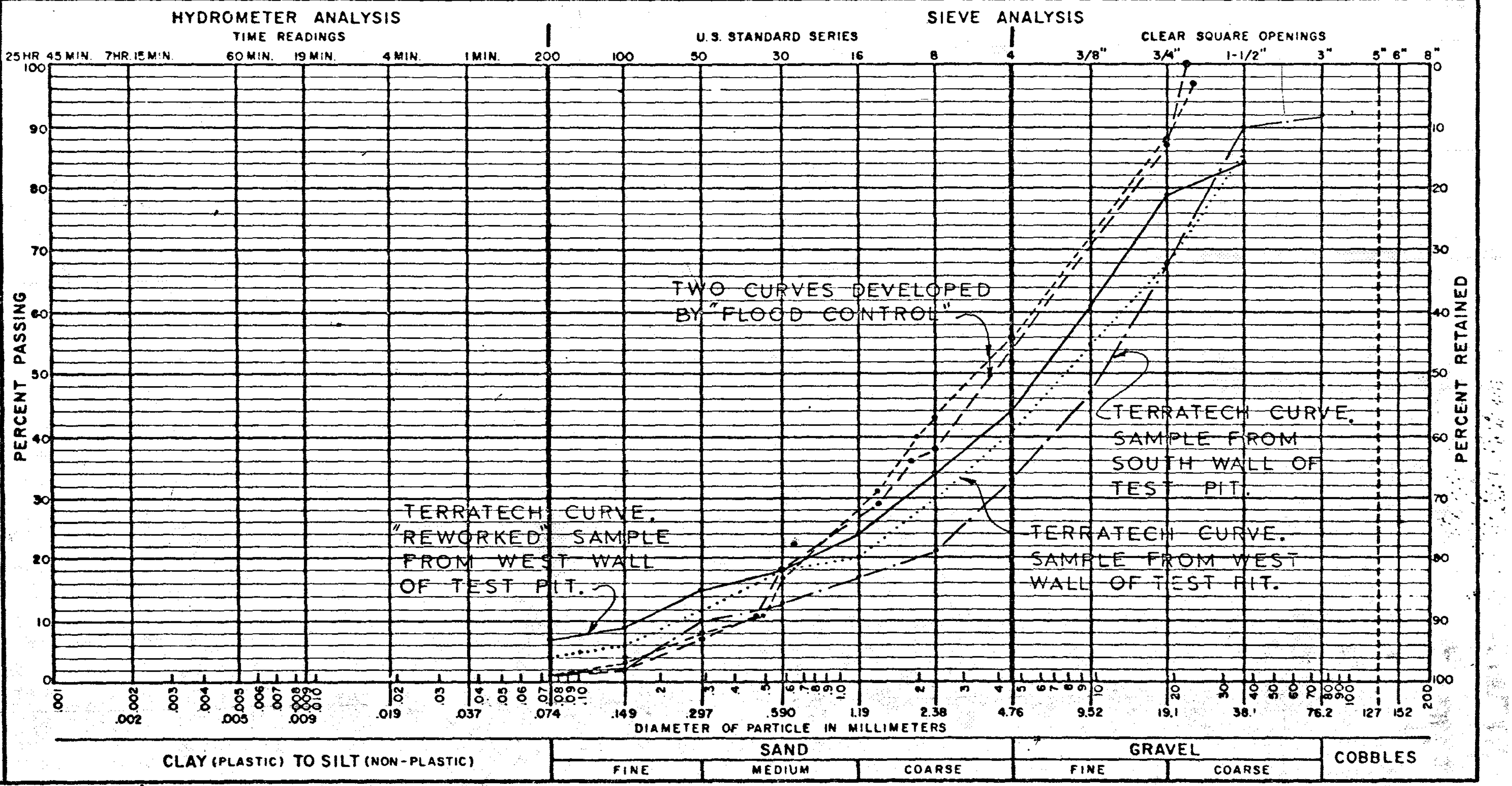
PROJECT 1099

TERRATECH

Hole No.
Tested By
Area
Appr By
Date
Job No.
File No.
Fig. No.

GRADATION TEST RESULTS

LL									
PL									
PI									
NAT. W/C									
CLASSIF. SYMB.									
SAMPLE NO.									
DEPTH FT.									
HOLE NO.									



TWO CURVES DEVELOPED BY "FLOOD CONTROL"

TERRATECH CURVE, SAMPLE FROM SOUTH WALL OF TEST PIT.

TERRATECH CURVE, "REWORKED" SAMPLE FROM WEST WALL OF TEST PIT.

TERRATECH CURVE. SAMPLE FROM WEST WALL OF TEST PIT.

PROJECT 1099

TERRATECH

Hole No.

Tested By

Area

Appr. By

Date

Job No.

File No.

Fig. No.

GRADATION TEST RESULTS

LL									
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PI									
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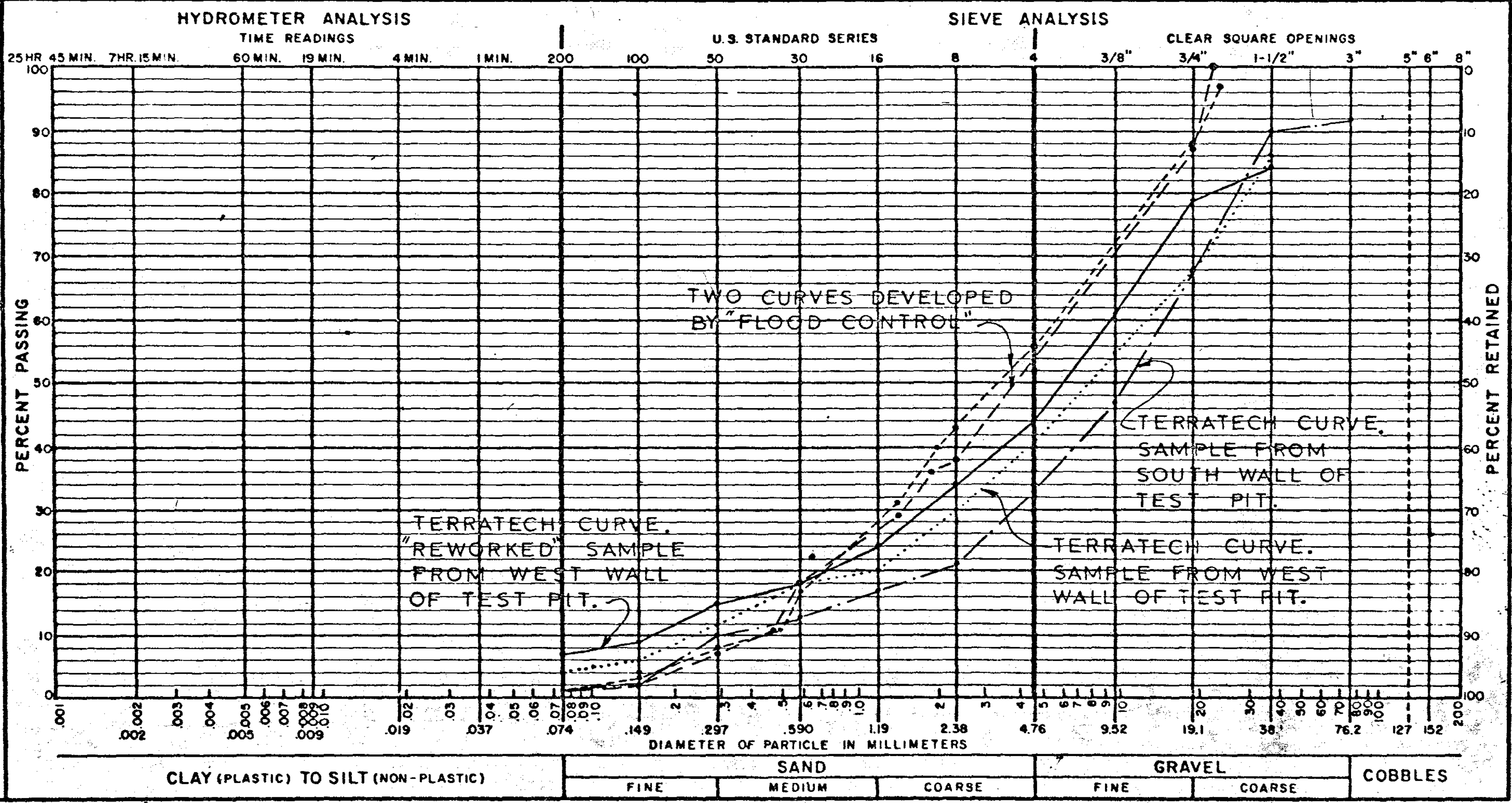
CLASSIF. SYMB.									
SAMPLE NO.									
DEPTH FT.									
HOLE NO.									



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TERRATECH CURVE. "REWORKED" SAMPLE FROM WEST WALL OF TEST PIT.

TERRATECH CURVE. SAMPLE FROM WEST WALL OF TEST PIT.